AUTHOR'S EDITION.

DEPARTMENT OF THE INTERIOR.
UNITED STATES GEOLOGICAL AND GEOGRAPHICAL SURVEY.
F. V. HAYDEN, U. S. Geologist-in-Charge.

REVIEW

OF THE

RODENTIA

OF THE

MIOCENE PERIOD OF NORTH AMERICA.

BY

E. D. COPE, N. A. S.

EXTRACTED FROM THE BULLETIN OF THE SURVEY, Vol. IV, No. 4.

WASHINGTON, September 19, 1881.

Art. XV.—Review of the Rodentia of the Miocene Period of North America.

By E. D. Cope, N. A. S.

RODENTIA.

Members of this order were very abundant during the White River and Truckee epochs in North America. They are referable to thirty-one species and eight genera. Of these genera three still exist in the regions where their fossil remains are found. These are *Sciurus*, *Hesperomys*, and *Lepus*. All of them occur in the Truckee beds, while the first-named only has been found in the White River formation. All of the species belong to the three great divisions of the order which now inhabit North America, while the fourth, the *Hystricomorpha*, which is very sparingly represented on the continent, has not yet been detected in the formations in question. It appears in a single species of porcupine in the Loup Fork beds.

The four primary divisions of the order *Rodentia* are thus defined, principally after Brandt and Alston.

I. Incisor teeth $\frac{2}{2}$. Fibula not articulating with the superior condyle of the calcaneum. No intertrochlear crest of humerus.

1. Mandible with the angular portion springing from the outer side of the bony covering of the lower incisor. Fibula distinct from tibia. "Malar bone not supported below by a continuation of the maxillary zygomatic process." An interpterygoid fissure.....HYSTRICOMORPHA.

2. Mandible with the angle in the plane of or springing from the inferior edge of the covering of the alveolus of the inferior incisor, more or less rounded; coronoid process high, falcate. Fibula distinct from tibia. No interpterygoid fissure.....SCIUROMORPHA.

3. Mandible with the angular portion springing from the inferior edge of the sheath of the inferior incisor (except *Bathyerginæ*). Fibula coössified with the tibia. Malar short, usually supported on a maxillary process. No interpterygoid fissure (except in *Bathyerginæ*).....MYOMORPHA.

II. Incisor teeth $\frac{1}{1}$. Fibula articulating with the condyle of the calcaneum. An intertrochlear crest of humerus.

4. No true alisphenoid canal; fibula ankylosed to tibia below; angle of mandible in the plane of the incisive alveolus.....LAGOMORPHA.

These groups, as is well known, include families and genera which display adaptations to various modes of life. Some are exclusively sub-

terranean, others are arboreal, and some live on the surface of the ground. Of the latter, some are provided with formidable spines as a protection against enemies, while others depend for their safety on their speed. Of the latter character are the *Leporidæ* of the *Lagomorpha*, and I wish to note how that they have superadded to the ordinary rodent structure certain points which also characterize the most specialized *Perissodactyla* and *Artiodactyla* among ungulates. The fusion of the inferior part of the fibula with the tibia (found also in the *Myomorpha*) belongs to the higher types of these orders. The strong intertrochlear ridge of the humerus is an especial feature of the groups mentioned, distinguishing them from the lower types in all the orders. The articulation of the fibula with the calcaneum, mentioned by Mr. Alston, is a character of the of the *Artiodactyla*. Associated with these is the elongation of the bones of the limbs, especially the posterior one. The modification of the tarsus in *Dipus* (the jerboas) evidently has a direct relation to the projectile force transmitted through the hind legs in rapid progression by leaping. Here the metatarsals are coössified into a cannon bone, though, as there are three bones involved, the result is somewhat different from the cannon bone of the *Ruminantia*.

The species of the American Miocenes, including Loup Fork formation, are distributed as follows:

	White River.	Truckee.	Loup Fork.
HYSTRICOMORPHA.			
Hystricidæ.			
Hystrix, L			1
SCIMOMORPHA.			
Mylagaulidæ.			
Mylagaulus, Cope			2
Fam. ?			
Heliscomys, Cope	1		
Castoridæ.			
Eucastor, Leidy			1
Castor, L	1	2	1
Ischyromyidæ.			
Ischyromys, Leidy	1		
Sciuridæ.			
Meniscomys, Cope		4	
Gymnoptychus, Cope	2		
Sciurus, Linn	1	2	1
MYOMORPHA.			
Muridæ.			
Eumys, Leidy	1		
Hesperomys, Waterh		1	1
Paciculus, Cope		2	
Geomyidæ.			
Pleurolicus, Cope		3	
Entoptychus, Cope		5	
LAGOMORPHA.			
Leporidæ.			
Palæolagus, Leidy	4	1	
Panolax, Cope			1
Lepus, Linn		1	

Many of the above genera stand in evident genetic connection with existing forms. The Miocene Castors doubtless include the ancestor of the modern beaver. The *Ischyromys* is a primitive type of the *Sciuridæ*, and *Gymnoptychus* connects it directly with the existing forms by the character of its molar teeth. *Eumys* is the primitive form of *Hesperomys*, as *Paciculus* is of *Sigmodon*. *Entoptychus* and *Pleurolicus* are the near ancestors of the *Geomyidæ* of the Pliocene and present periods. *Palæolagus*, *Panolax*, and *Lepus* form a direct genetic line. The ancient genera all differ from their modern representatives in the same way; that is, in the greater constriction of the skull just posterior to the orbits and accompanying absence of postorbital processes. This relation may be displayed in tabular form as follows:

Skull wider behind orbits.		Skull narrower behind orbits.	
Postorbital processes.	No postorbital processes.	Postorbital processes.	No postorbital processes.
.....	Castor fiber.....	.....	Castor peninsulatus.....
Sciurus.....	.....	.....	Ischyromys.....
.....	Hesperomys.....	.....	Eumys .....
Lepus.....	.....	.....	Palæolagus .....

None of this species of this fauna are of larger size than their modern representatives. In the cases of the beaver, squirrels, and rabbits, the ancient species are the smaller.

SCIUROMORPHA.

SCIURUS Linn.

In this genus the molars are $\frac{5}{4}$ or $\frac{4}{4}$, the first superior small when present. The grinding surfaces of the crowns when unworn present in the superior series a single internal cusp, which is low and antero-posterior. From this there extend to the external border of the crown two low transverse ridges, whose exterior terminations are somewhat enlarged. In the lower jaw the transverse ridges are not visible, and there is a low tubercle at each angle of the crown, between which there may be others on the border of the crown. Attrition gives the grinding surface of the latter a basin-like character. The *foramen infraorbitale* is a short, narrow fissure, situated in the inferior part of the maxillary bone in front of its tooth bearing portion, but descending nearly to the level of the alveolar border.

The well-known characters of this genus are found in the mandibles of species which I obtained from the White River Miocene beds of Colorado and Oregon. The teeth display the subquadrate form of this genus, without any tendency to the transverse enlargement seen in *Arctomys*, *Cynomys*, and *Spermophilus*. Two of the species, *S. vortmani* and *S. relictus*, are as large as our gray and red squirrels, respectively, and the third, *S. ballovianus*, is about the size of the *Tamias quadrivittatus*.

GYMNOPTYCHUS Cope.

Paleontological Bulletin, No. 16, p. 5 (August 20, 1873); Ann. Report U. S. Geolog. Surv. Terrs. 1873 (1874), p. 476.

Dental formula: I. $\frac{1}{1}$; C. $\frac{0}{0}$; M. $\frac{4}{4}$. Crowns of the superior molars supporting two crescents on the inner side, and two cusps on the external side opposite to them. Each cusp sends a transverse crest to the concavity of the corresponding crescent. The adjacent horns of the crescents are united, and the connecting portion sends a transverse crest into the interval between the cusps. The opposed horns of the two crescents each send a crest round the anterior and posterior sides of the crown, of which they form the borders. Incisors simple. The walls of the alveolus of the inferior incisor produced into a tuberosity on the external side of the base of the ascending ramus.

The above characters define a genus which, when fully known, will in all probability be referred to near the existing genus *Sciurus*. In confirmation of this opinion, I add that the alveolar sheath of the inferior incisor is in the vertical plane of the ramus; the incisive foramen does not invade the maxillary bones, and the *foramen infraorbitale exterius* is a small fissure situated in the inferior portion of the maxillary bone, well in advance of both the orbit and first molar tooth.

As compared with the existing genera, it differs in the structure of the molar teeth. The arrangement of the tubercles and crests is more complex than in any of them, excepting *Pteromys*. Thus in all of them there is but one internal crescent of the superior molars, and but two or three cross-crests; while in the inferior molars the arrangement is unlike that of the superior teeth, the cross-crests being marginal only. In *Pteromys* (F. Cuv.) the transverse valleys of the inferior series of *Gymnoptychus* are represented by numerous isolated fossettes. The structure of the molars in the fossil genus is exactly like that which I have described above as found in *Eumys*, extending even to the details. This is curious, as that genus is a Myomorph.

The protrusion of the posterior extremity of the alveolar sheath of the inferior incisor on the outer side of the ascending ramus is not exhibited by the North American *Sciuridæ*, which I have examined, nor by any of the extinct genera herein described, excepting *Castor* and the *Geomyidæ*. It is seen in a lesser degree in *Mus musculus*, *Hesperomys leucopus*, *Meriones hudsonius*, and *Arvicola riparia*, all *Muridæ*.

Whether this genus possesses a postfrontal process I have been unable to ascertain. Its absence would not in my opinion isolate it from the *Sciuridæ*, as I accord with Dr. Coues in his estimate of the value to be attached to this character.

Of other portions of the skeleton I possess incomplete humerus, ischium, femur, and tibia. Most of these are appropriate in size to the *G. minutus*, which is also the most abundant species. A fragment of a larger femur belongs perhaps to the *G. trilophus*.

The *humerus* is rather slender, and the deltoid crest does not exhibit the prominence so usual in the *Muridæ*. It is most prominent on the antero-external aspect of the shaft near its middle; an external as well as an anterior ridge diverges from it upwards. The condyles have no intertrochlear ridge, and the external trochlea is not more extended transversely than the internal, measuring from the fundus of the groove. There is a moderate internal epicondyle, and the arterial foramen is distal, and opens anteriorly below and on the external face above. The bridge is slender and moderately oblique. The external border is acute and twisted.

The *ischium* is characterized, like that of other *Sciuridæ*, by the presence of a spine or process which is wanting in North American *Muridæ*, but is present in *Perognathus*. The bone is rather short, the tuberosity is but little enlarged, and the pubic process not very wide. The proximal end of a *femur* may belong to *Eumys elegans*, but is too small according to usual data. The great trochanter is elevated as high as the head, from which a deep notch separates it; its posterior or fossa is pronounced. The little trochanter is very prominent, projecting at right angles to the shaft. The shaft is broken, so that the presence of a third trochanter cannot be ascertained. The distal end of the femur is characterized by a patellar groove of moderate width, with fairly elevated ridges which are continued well posteriorly on the shaft, but not further than in existing *Sciuridæ*, and not so far as in *Palæolagus*. The distal extremity of the *tibia* displays characters of the *Sciuridæ* as distinguished from those of *Muridæ* and *Leporidæ*. The fibula is of course distinct, and the external trochlear groove opens from its fundus outwards. The internal groove is narrower and is bounded internally by a vertical malleolus, which has no distal articular facets, and which does not project, but is flat on the inner side. The greater part of the posterior face is occupied by the bones of the wide groove for the tendon of the *flexor longus pollicis* muscle. Its inferior edge is produced downwards as far as the malleolus, from which is is separated by the deep groove for the *tibialis posticus* and *flexor longus digitorum* muscles. This groove is marked on the inner side of the distal portion of the shaft, its anterior border being especially well defined.

Two species of this genus are certainly known. They belong to the White River horizon of Colorado. They differ, so far as known, chiefly in size, and in the proportions of the inferior premolar tooth.

MENISCOMYS Cope.

Paleontological Bulletin No. 30, p. 5, Dec. 3, 1878; Proceedings American Philosophical Society, 1878 (1879), p. 67.

The characters of this genus are derived from the dentition of both jaws, and from portions of the cranium which are preserved. The molars are rooted, and number $\frac{5}{4}$ or $\frac{3}{1}$ $\frac{3}{3}$. Those of the superior series

are without enamel inflections, and the triturating surface exhibits two external and one internal crescentic sections of the investing enamel. On the second superior molar there are three external crescents, and the first molar is simply conic. Between the inner and external crescents there are the curved edges of enamel plates directed obliquely and transversely. The grinding surfaces of the inferior molars display, in the unworn condition, curved transverse crests, connected longitudinally on the median line; on wearing, the lateral emarginations of the enamel become shallower, disappearing from the inner side, but remaining on the outer. Incisor teeth not grooved. *Foramen infra-orbitale anterius* small, inferior, and near the orbit. Postorbital processes; no sagittal crest.

The characters of the dentition of this genus resembles those of the genus *Pteromys*, which is now confined to Asia and the Malaysian Archipelago. The superior molars differ from those of *Pteromys* in wanting all re-entrant enamel inflection.

The general characters of the skeleton are unknown. A femur is rather slender, and a tibia rather elongate, showing that the limbs are not short.

Four species of this genus are known to me, all from the Truckee Miocene of Oregon. They differ considerably in the details of the structure of the molar teeth. Their more prominent characters may be set forth as follows:

I. Superior molars short-rooted, with the external face plane; inferior molars with a prominent median transverse crest.
Smaller; dental crests fewer, simple, not crenate ..... *M. hippodus.*
II. Superior molars long-rooted; external face of crowns inflected forming two V's; no median transverse crest on inferior molars.*
a. Crests of superior molars fewer, simple, not crenate.
Larger; crowns short ..... *M. liolophus.*
aa. Crests of superior molars more numerous and much crenate.
Smaller; plications of inferior molars shallow; borders raised ..... *M. cavatus.*
Larger; plications of inferior molars profound ..... *M. nitens.*

There is a suggestive resemblance between the forms of the molar teeth of the *Meniscomys hippodus* and those of the *Haplodontia rufa* now living in Oregon. The two genera have doubtless had a common origin, but the present differences are considerable. Thus the *Haplodontia* has an extended osseous cavum tympani, which does not exist in *Meniscomys*.

This genus appears to be referable to the *Sciuridæ*.

ISCHYROMYS Leidy.

Proceed. Acad. Nat. Sci. Philad. 1856, p. 89; Extinct Fauna Dakota and Nebraska 335.—*Colotaxis* Cope, Paleontological Bulletin, No. 15, p. 1.

Char. gen.—The essential features are, dentition, I., $\frac{1}{1}$; C., $\frac{0}{0}$; M., $\frac{5}{4}$; the molars with two crescents on the inner side above, each of which

*Not seen in *M. liolophus.*

gives rise to a cross-ridge to the outer margin. In the mandibular series the crests and crescents have a reversed relation. No cementum.

To the above characters given by Dr. Leidy, I have added the absence of postfrontal processes, and the superior position of the infraorbital foramen. I now add that the pterygoid fossa is large, and that its inner and outer plates are well developed, and subequal. The palate is excavated posteriorly. The acuminate anterior part of the malar bone extends as far forwards as the front of the orbit. There is no tuberosity on the side of the superior diastema near the premolar teeth. In the mandible the posterior extremity of the incisive alveolus is not distinct from the ascending ramus.

Nothing has been heretofore published respecting the characters of the remaining portions of the skeleton. Those which I possess are the distal extremities of humeri, and a tibia, astragali, and portions of the pelvis. The condyles of the humerus are narrow antero-posteriorly. The internal flange descends at once to the fundus, leaving a long external cylindrical portion without intertrochlear ridge. Anteriorly this portion is cut into for half its length by the ligamentous fossæ. There is a large internal epicondyle, which is constricted by a neck at the base, and presents a compressed edge inwards and upwards. The arterial canal opens above on the interior side of the humerus. There is no external epicondyle.

The section of the *ilium* at its base and at its middle is triangular. There is an angle along the middle of its external face which supports a moderately prominent tuberosity, a little above the acetabulum. On the anterior margin a little higher up is a short, compressed, rather prominent process, which probably represents the anterior inferior spine. From this point posteriorly the internal face of the ilium is deeply concave, producing an attenuation of the inner wall of the acetabulum. The ischium is rather narrow at the base.

The distal portion of the tibia is much like that of *Arctomys*, *Gymnoptychus*, and other *Sciuridæ*. The posterior median process is very large and is shallowly grooved; the usual deep tendinous groove separates it from the internal malleolus. The trochlear grooves are deep and well separated; the fibular surface is short. The head of the astragalus is horizontally oval, and is separated from the trochlear portion by a neck of moderate length. It extends obliquely inwards, so that the internal margin of the head is interior to the line of the inner margin of the trochlea. The sides of the latter are vertical. It is considerably wider than long; the trochlear carinæ are marginal, and the external is considerably more elevated than the inner. The separating groove is profound but open. The posterior inferior fossa is small and foramen-like.

Besides the very different form and position of the infraorbital foramen, this genus differs from *Gymnoptychus* in the excavation of the posterior edge of the palate.

Dr. Leidy remarks that this genus belongs to the family of the *Sciuridæ*. This is indicated by the dental characters; but in some other respects there is a greater divergence from the squirrels and marmots than is the case with the preceding genus, *Gymnoptychus*. Thus, the large *foramen infraorbitale anterius* occupies the elevated position at the origin of the zygomatic arch seen in the porcupines and cavies. There is no superciliary ridge nor postorbital process as in most *Sciuridæ*, but the front is contracted between the orbits in the same manner as, but to a less degree than, in *Fiber*, and the Eocene *Plesiarctomys*, Brad. Both the last named and *Ischyromys* present many points of resemblance to Pomel's tribe of *Protomyidæ*, but differ from any of the genera he has included in it.

This family is thus defined by Pomel:* "infraorbital foramen large as in the *Hystricidæ*, and by the position of the angular apophysis of the mandible almost in the general plane of the horizontal ramus. The jugal bone, at least in those species where we have observed it, is very much enlarged at its anterior portion, and the orbit is almost superior."

These characters apply to *Ischyromys*, excepting as regards the malar bone, which is principally unknown in the latter.

Another family, the *Ischyromyidæ*, has been proposed by E. R. Alston for the reception of this genus, to which he thinks with me† *Plesiarctomys* (= *Pseudotomus*) should be referred. He thus defines the family:‡ "Dentition as in *Sciuridæ*; skull resembling *Castoridæ*, but with the infraorbital opening large, a sagittal crest; no postorbital processes; palate broad; basioccipital keeled."

Doubtless *Ischyromys* belongs to an extinct family, but which of the above names is available for it I do not yet know. I would characterize it as follows:

Dentition as in *Sciuridæ*; infraorbital foramen large, superior; pterygoid fossa large, with well-developed exterior as well as interior walls; a sagittal crest.

The superior position of the infraorbital foramen and the well-developed pterygoid laminæ are characters found in the *Muridæ*.

But one species of this genus is known.

CASTOR Linn.

Syst. Nat. I, p. 78, 1766.—*Steneofiber*, E. Geoffr., Revue Encyclopédique, 1833.—"*Chalicomys* Meyer, Neues Jahrbuch, 1838, p. 404, et 1846, p. 474."—*Palæocastor* Leidy, Extinct Mammalia Dakota and Nebraska, 1869, p. 338.

The family of the *Castoridæ* differs from the *Sciuridæ* in the absence of postorbital angles or processes and the presence of a prolonged tube of the meatus auditorius externus. In both of these points it agrees with the *Haplodontiidæ*, a family which Mr. Alston has distinguished

* Catalogue Method. et Descr. de Vertébrés Foss. de le Bass. de la Loire, 1853, p. 32.
† Annual Report U. S. Geol. Survey Terrs. 1873 (1874), p. 477.
‡ Proceed. Zool. Society London, 1876, p. 78.

from the *Castoridæ* on various grounds. I do not think any of his characters are tenable, excepting that drawn from the form of the mandible, which is expressed thus in Mr. Alston's diagnosis: "angular portion of mandible much twisted." This character will be better described as follows: Angle of mandible with a transverse edge due to inflection on the one hand, and production into an apex externally; the inflection bounding a large interno-posterior fossa.

Mr. Alston enumerates four genera of *Castoridæ—Castor*, *Diobroticus*, *Steneofiber*, and *Castoroides*. J. A. Allen has shown that the last-named genus cannot be referred to this family. The characters of *Diobroticus*, as given by Alston, are as follows: "Skull much as in *Castor*. Third upper molar and lower premolar elongate, with four enamel folds, the rest with only two; all the folds soon isolated." This diagnosis appears to separate the genus satisfactorily. The definition of *Steneofiber* is as follows: "Parietals not parallelogrammic; interparietal subhexagonal; basioccipital not concave; grinding teeth as in *Castor*, the subsidiary folds sooner isolated." The distinction from *Castor* here rests exclusively on the forms of the parietal, interparietal, and basioccipital bones. This kind of definition is always of questionable validity, as the terms "parallelogrammic," "hexagonal," etc., are not intended to be exactly used and cannot be exactly applied. The *Castor* (*Steneofiber*) *peninsulatus* illustrates this fact, for there is no striking difference in the forms of the two bones to which these terms are applied, as compared with the *Castor fiber*. The basioccipital bone differs from that of the beaver, but not so as to conform to J. W. Alston's diagnosis of the genus *Steneofiber*. Its inferior surface is concave, but doubly so, as a keel occupies the median line. In the *S. viciacensis*, according to Filhol, this region is shallowly concave, without median keel. Although important as specific characters, these variations do not appear to me to require the recognition of as many genera. The possession of the epitrochlear foramen in the *S. viciacensis* is at first sight an important character. Mr. Filhol, however, informs us that of thirty-four humeri which he has studied, sixteen possess the foramen, and in eighteen it is wanting.

The *Castor tortus* was described by Leidy from the Loup Fork formation. He coined the subgeneric name *Eucastor* for it without corresponding definition. In his monograph of the *Castoridæ*, J. A. Allen referred this species* to a genus distinct from *Castor*, and defined it, using for it Leidy's name *Eucastor*. This genus appears to me to be valid. The three genera of *Castoridæ* will then be defined as follows:

Molars and premolars with one inner and two or three outer folds ..... *Castor*.
"Inferior premolar and third superior molar elongate, with four enamel folds; the rest with only two." ..... *Diobroticus*.
Superior premolar enlarged, with one inner fold; inferior molars small, with two lakes. ..... *Eucastor*.

* Monographs of North American Rodentia, Coues and Allen, U. S. Geol. Surv. Terrs., 1877, xi, p. 450.

Some affinity probably exists between this family and the *Mylagaulidæ*, which followed in the Loup Fork epoch.

The species of *Castor* may be distinguished as follows. I do not know the *C. nebrascensis** from the White River, nor the occipital bone of the *C. pansus*,† from the Loup Fork formation.

I. Basioccipital bone deeply concave below:
  Angle of lower jaw not deflected ..... *C. fiber.*
II. Basioccipital shallowly concave below:
  Angle of lower jaw deflected ..... *C. viciacensis.*
III. Basioccipital concave below with a median keel: angle of lower jaw not deflected.
  Palate wider; size medium ..... *C. peninsulatus.*
  Palate narrower; size small ..... *C. gradatus.*

Castor peninsulatus Cope.

Steneofiber? nebrascensis Leidy, Cope, Bulletin U. S. Geological Survey Terrs. V, 1879, p. 55.

This species is about the size of a large prairie marmot—*Cynomys ludovicianus*. It was abundant in Oregon during the period of the Truckee Miocene. Leidy originally described the closely allied *C. nebrascensis* from the White River beds of Nebraska, but I have never obtained it from that formation. Another and similar species, *C. pansus* Cope, is common in the Loup Fork beds of Nebraskaand New Mexico.

Several well preserved skulls from Oregon display characters not visible in specimens heretofore collected, and which enable me to make fuller comparisons with the European *C. viciacensis*, so fully described by M. Filhol.‡

The postorbital constriction is much greater in this species than in the *C. viciacensis*, and greater than in the *C. nebrascensis* from the White River beds. The straight anterior temporal ridges are in line with the superciliary borders, and unite into a sagittal crest at the constriction. In the *S. viciacensis* they continue separate beyond this point one-fourth the distance to the supraoccipital crest. The zygomata are wide, and the malar ridge is very prominent anteriorly, overhanging the face, and curving rather abruptly to the base of the muzzle. The latter is rather wide, with parallel sides, and is flat above. The brain-case expands rather abruptly from the interorbital constriction, and is rather flat above. The infraorbital foramen is a narrow vertical oval and is situated low down in the vertical line with the anterior extremity of the malar angular edge. It is a little nearer the line of the first molar than the posterior border of the superior incisor. The incisive foramina are relatively larger than in the beaver, and are chiefly in the premaxillary bone. The palate between the anterior molars is as wide as the transverse diameter of the first molar. There is no distinct fossa of the

* *Steneofiber nebrascensis* Leidy, Proceed. Academy Phila., 1856, 89; 1857, 89; *Chalicomys nebrascensis* Leidy, l. c., 1857, 176; *Palæocastor nebrascensis* Leidy, Ext. Mammalia Dakota and Nebraska, 1869, p. 338, xxvi, Figs. 7–11.

† *Steneofiber pansus* Cope, Report Capt. G. M. Wheeler, iv, pt. ii, 1877, p. 297.

‡ Étude des Mammifères Fossiles de Saint-Grand-le-Puy, Allier. Bibl. de l'École des Hautes Études, XIX, Art. I, p. 44, 1879.

maxillary bone in front of the orbit as represented by Filhol in the *C. viciacensis*. The pterygoid fossa is wide, with the inner process the longer, and reaching the otic bulla. The latter are large and obliquely placed; the meatal borders are produced into a short tube which is not so long as that of the *C. fiber*. Its superior border is quite prominent, overhanging the inferior, and projecting more than represented by Mr. Filhol in the *C. viciacensis*. There is a strong ridge of the squamosal bone extending posteriorly from the base of the zygomatic process, which overhangs a fossa. This fossa is further defined posteriorly by the tympanic tube. The fossa is larger and deeper than in either *C. fiber* or *C. viciacensis*. Below its superior bounding ridge is a large subsquamosal foramen. The mastoid bone is distinctly exposed between the squamosal and the occipital, and its surface is separated from that of the former by a groove which is not so well marked in the *C. fiber*. Its inferior angle is in contact with the bulla, and is shorter than the paroccipital process. The latter is short, not extending below the line of the condyles, and is directed downwards, not posteriorly as in *C. fiber*. The occiput is nearly vertical and flat, excepting laterally, where there are two fossæ, a superior and inferior, the latter the longer, and extending to the inferior surface.

The premaxillo-maxillary suture is just half way between the anterior molar and the superior incisor, and is vertical to opposite the middle of the incisive foramen, and then turns backwards. The fronto-maxillary and fronto-nasal sutures are in one transverse line across the front. The malar-maxillary suture is behind the anterior border of the zygoma, thus confining the malar bone to the zygoma. The latter is much expanded in a vertical direction, but has no postorbital angle, resembling in this respect the *C. viciacensis* rather than the *C. fiber*. Its posterior portion extends well posteriorly and below almost all of the squamosal part of the zygoma. The parietal is of a parallelogrammic form; the anterior inner border cut obliquely by the frontal, and the posterior inner border cut out for the supraoccipital. The latter bone has an oval form, narrowed anteriorly and truncate posteriorly.

I describe a mandibular ramus of a second individual. It unfortunately has the coronoid and the angle broken off. The base of the latter is concave on the inner side. The external face of the ramus is everywhere convex. The base of the coronoid is separated from the molar line by a wide groove. The anterior base is opposite the second molar. The incisive alveolus is continued upwards and backwards, and ceases in a protuberance which is external to the plate which connects the condyle with the coronoid process, and is separated from it by a fossa. The condyle is subglobular, and has considerably more external than internal articular surface. The series of inferior molar teeth is quite oblique, descending posteriorly.

Dentition.—The grinding surfaces of the superior molars are none of them longer than wide, and in all but the first the transverse diameter exceeds the antero-posterior. The dimensions diminish posteriorly in all

the measurements. There is one inflection of the sheathing enamel on each side of the crown in all the molars in their present state of wear. The positions of the lakes indicate that in an earlier stage there were two external inflections. At present all the molars display a fossette external to the fundus of the internal inflection. Besides this there are two others in the first molar, and one other in the fourth. Posterior to the external inflection there is one fossette in the first and third molars, two on the fourth, and none on the second, where it is probably worn out. According to Leidy there are three in this position in all the molars in the *C. nebrascensis*, and two in the position first described. According to Filhol, there is but one in each position, in about the same stage of wear, in the *C. viciacensis*.

The inferior molars display a deep external inflection, and three transverse lobes on the inner side. These probably represent inflections at an earlier stage of wear; the median one is still continuous with the sheathing enamel on the first molar (Pm. IV). The sizes of the inferior molars increase anteriorly regularly, excepting that the first is relatively a little longer than the others.

Measurements of skull.

	M.
Length from inion to edge of nasals	.067
Length from edge of nasals to interorbital constriction	.034
Length of muzzle to preorbital angle of maxillary	.018
Width of skull at paroccipitals	.025
Width of skull at posterior edge of squamosal	.034
Width at zygomata posteriorly	.056
Width at interorbital constriction	.006
Width between anterior parts of orbits	.0275
Width at base of muzzle	.018
Length from occipital condyle to front of otic bulla, inclusive	.018
Length from bulla to last molar tooth	.008
Length from first molar to base of incisor	.023
Length of superior molar series	.0195
Diameters of first molar { anteroposterior	.0045
Diameters of first molar { transverse	.0045
Diameters of fourth molar { anteroposterior	.0030
Diameters of fourth molar { transverse	.0035

Measurements of mandible.

Length from condyle to incisor tooth	.0390
Length from incisor to Pm. IV	.0105
Length of inferior molar series	.0145
Diameters of Pm. IV { anteroposterior	.0047
Diameters of Pm. IV { transverse	.0040
Diameters of M. I { anteroposterior	.0030
Diameters of M. I { transverse	.0040
Diameters of M. IV { anteroposterior	.0030
Diameters of M. IV { transverse	.0035
Depth of ramus at diastema	.0100
Depth of ramus at Pm. IV	.0130
Depth of ramus at M. III	.0100

A few bones accompany the mandible, all having been cut from the same fragment of matrix. The head of the femur is perfectly round, and is bounded by a well-defined neck. The great trochanter incloses a large fossa. The lesser trochanter is large; the third trochanter is not prominent as it is in *C. vicinacensis*. The shaft is generally flattened, with its long diameter transverse. The condylar extremity is flattened, and the rotular groove is wide, and the condyles well separated. The epicondylar angles are distinct, but not so prominent as in *S. vicinacensis* (see Filhol, *l. c.*, Pl. VI, Figs. 13, 14). The general form of the femur is robust, as in that species.

The distal extremity of the tibia resembles that of *Sciuridæ* generally, especially in the large size of the external posterior angle. Its diameters are small, and the distal part of the shaft is slender and subcylindrical. The crest extends well down from the proximal end, being much stronger than in the true squirrels, and bounds a longitudinal fossa. The fibular facet of the tibia overhangs extensively, and bounds a rather narrow proximal fossa. This continues into a narrow shallow groove on the posterior face of the shaft, which disappears near the middle of its length. The proximal half of the shaft is much compressed. The inner face is smooth and gently convex. The crest sinks rapidly into the head, and the femoral facets are well separated. The tibia resembles that of *C. vicinacensis*, but is more compressed in its proximal half.

Measurements of hind leg.

		M.
Length of femur		.057
Width of femur at head		.019
Width of femur shaft below third trochanter		.009
Width of femur at epicondyles		.015
Width of condyles of femur		.013
Antero-posterior diameter at condyles		.011
Antero-posterior diameter of head		.009
Diameters of head of tibia	anteroposterior	.012
	transverse	.014
Diameters of distal end of tibia	anteroposterior	.006
	transverse	.0085
Antero posterior diameter	above middle	.010
	below middle	.005

I have referred to this species in former catalogues of the vertebrate fauna of Oregon as the *Castor nebrascensis* of Leidy. It is very nearly allied to that species, but I find the following differences: First, the postorbital constriction is narrower; second, there are fewer fossettes on the posterior half of the molar teeth, but one or two. Leidy figures two or three in the species described by him.

MYLAGAULUS Cope.

Bulletin U. S. Geological Survey of the Territories, IV, p. 384, May 3, 1878.

Inferior molars three, rootless; the first much larger than the others. Enamel inclosing the first molar not inflected; but numerous fossettes

on the grinding surface of the crown, whose long diameter is antero-posterior.

The only lower jaw of a species of this genus in my possession presents a small part of the base of the angle and of the coronoid process. These parts are so nearly in the plane of the incisive alveolus as to lead to the belief that the genus *Mylagaulus* belongs to the suborder *Sciuromorpha*. The rootless teeth with deep enamel fossettes approximates it to the *Castoridæ*, but it appears to me that a new family group must be established for its reception.* Such characters are the presence of only three inferior molars, and the entire independence of the enamel fossettes of the external sheathing enamel. It is worthy of investigation whether the *Hystrix refossa* Gèrv. has any relation to this family.

As a generic feature, the preponderance of the first true molar over all the others is remarkable. It performed the greater part of the masticatory function, as the second molar is a small tooth, and the third one quite insignificant, and in the *M. monodon* probably early shed.

The genus is only known from the Loup Fork formation. There are two species, both from the adjacent regions of Kansas and Nebraska.

Mylagaulus monodon Cope.

American Naturalist, 1881, July.

The larger species, and represented by a left mandibular ramus, from which the more fragile parts have been broken. The form of the ramus is rather compressed and deep, and the line of molar teeth is very little oblique to its plane. The diastema is short and concave, and the incisive alveolar margin is elevated. The base of the coronoid process originates opposite the middle of the second molar. The internal and external faces of the ramus are nearly plane, and the inferior border is transversely rounded behind the position of the incisive alveolus. The The masseteric fossa is not defined below, and its anterior oblique bounding ridge is indistinct.

The alveolus of the third molar is close to the fundus of the incisive alveolus, and is so shallow as to lead to the belief that it is readily and early shed. That of the second molar is much deeper; it is small, and its long axis is directed at 45° angle inwards and forwards. The ledge between it and the base of the coronoid process is rather wide. The masticating surface of the first molar is longer than wide, forming an oval rather narrower anteriorly than posteriorly. Its extent on a line drawn through the centers of the alveoli is twice as great as that of the second molar. The fossettes are linear, and lie in three parallel lines. The internal line contains three fossettes, the middle one three, and the internal one two. The anterior one of the internal line does not extend so far anteriorly as the extremities of the other two lines; its posterior end also is not in line with the posterior fossette of the same line, but begins opposite the space between it and the last fossette of the middle

*See American Naturalist, July, 1881, where this is done.

series. The inferior incisor is rather large. Its section is nearly triangular. The enamel face is entirely smooth.

Measurements.	M.
Length of ramus included in chord of incisor tooth	.0300
Length of inferior molar series	.0200
Diameters grinding surface M. I { anteroposterior	.0105
Diameters grinding surface M. I { transverse	.0050
Elevation grinding surface, M. I., inner side	.0032
Length of diastema	.0100
Width anterior surface of incisor	.0050
Depth of ramus at M. III	.0155

This species was about the size of the wood-chuck (*Arctomys monax*), to judge by the dimensions of its lower jaw. It is larger than the *M. sesquipedalis*, and has a different arrangement of the enamel fossettes. In that species, instead of being in three parallel lines, the middle line is only represented by its extremities. At the middle of the crown the fossettes of the internal line are incurved so as to be nearly in contact with the fossettes of the external line.

The *Mylagaulus monodon* was discovered by Wilbur J. Brous in Hitchcock County, Nebraska.

HELISCOMYS Cope.

Synopsis of New Vertebrata from Colorado (Miss. Pub. U. S. Geol. Survey Terrs.), 1873 (October), p. 3: Annual Report U. S. Geol. Survey Terrs. 1873 (1874), p. 475.

Inferior molars four, rooted, the crowns supporting four cusps in transverse pairs. A broad ledge or cingulum projecting on the external side from base of the cusps. The inferior incisor compressed, not grooved, and with the enamel without sculpture.

This genus is only represented by a small number of specimens, which are mandibular rami exclusively. Its special affinities therefore cannot be ascertained, and even its general position remains somewhat doubtful. There is some probability however that it belongs to the *Myomorpha*, as the type of dentition is much more like that of the genera of that group than those of the *Sciuromorpha*. To the *Hystricomorpha* it does not belong.

As compared with known genera of *Myomorpha*, it is at once separated from many of them by the presence of a premolar tooth. Among recent genera of this suborder, *Sminthus* possesses this tooth in both jaws, and *Meriones* in the upper jaw only. It is present in both jaws in the *Sciuromorpha* generally. The tubercles of the teeth resemble those of the *Muridæ*, but their disposition is unlike that of any existing North American genus. A remote approximation to it is seen in the genus *Syllophodus** of the Bridger Eocene formation, where there are four subquadrate molars with tubercles; but the latter form two transverse crests, with an additional small intermediate tubercle, and the wide cingulum is absent.

But one species of *Heliscomys* is known, the *H. vetus*.

* *Myops* Leidy ("*Mysops*") preoccupied.

MYOMORPHA.

EUMYS (Liedy nom.) Cope.

Annual Report of the U. S. Geological Survey of the Territories, F. V. Hayden in charge, 1873 (1874), p. 474.—*Eumys* Leidy (name only), Proceedings Academy Philada. 1856, p. 90; loc. cit. 1857, p. 89; Extinct Mamm. Dakota and Nebraska, p. 342.

Dental formula: I. $\frac{1}{1}$; C. $\frac{0}{0}$; M. $\frac{3}{3}$. Crowns of the superior molars supporting two external cones, and two internal tubercles of crescentic section which communicate with the former by transverse ridges. Inferior molars of similar constitution, but reversed, the conic tubercles being interior and the crescentic exterior. The posterior tubercles of the posterior molars reduced, and an additional one on the anterior extremity of the first molar. Superciliary ridges none, but the supraorbital borders converging towards the middle line, and meeting above the postorbital region. No indication of postfrontal processes. Infraorbital foramen rather large above, terminating below in a vertical fissure. Incisive foramen entering the maxillery bone extensively. Incisor teeth not grooved.

I only know this genus from the cranium anterior to the pterygoid region, the mandibles, and the dentition. These parts display the characters of the *Muridæ*, and in particular of the existing genus *Hesperomys*. The only character which I can find which has enabled me to distinguish *Eumys* from the latter genus is the extension upwards of the orbital fossæ so as to form an interorbital crest. In none of the Sigmodont genera of North America are the supraorbital borders contracted in this way, but the crest is seen in *Fiber* and in various degrees in the genus *Arvicola*, being as distinct as in *Eumys* in *A. xanthognathus*.*

A single species is certainly referrible to this genus, the *E. elegans*, which was abundant during the White River Miocene epoch. I have referred to the same genus a second species, in which the same characters are seen in the inferior molars; but as the frontal region is unknown, the reference was provisional only. This is the *Hesperomys loxodon** Cope, of the Loup Fork Miocene of New Mexico, a much smaller species than the *E. elegans*.

The typical species was originally described by Leidy, who gave it the generic name which I have adopted; but he at no time characterized the genus, or showed how it differed from others already known. This was first done by myself as above cited.

HESPEROMYS Waterhouse.

This recent genus had a representative in the Miocene period in North America, so far as the characters of the skull and dentition may be con-

* See Coues, U. S. Geol. Surv. Terrs. XI, Pl. IV, fig. 54.

sidered to be conclusive in evidence. It is not very probable that the indications thus obtained will be invalidated by other portions of the skeleton.

The molars are $\frac{6}{6}$, and the crowns support alternating tubercles separated by shallow open transverse valleys. These are, one on the inner and two on the outer sides of the superior series, and one on the outer and two on the inner side of the inferior. In the recent species, (*H. leucopus*) there are two inflections on the inner side of the first molar, but in the species here described that tooth is constricted at the position of the anterior internal loop, and does not regain its width, but continues narrowed to the anterior extremity. The infraorbital foramen is rather large.

It is probable that there is a second species of this genus in the Loup Fork beds besides the *H. loxodon* Cope.

PACICULUS Cope.

Paleontological Bulletin No. 31, p. 2, Dec. 24, 1879; Proceedings American Philosoph. Society, 1879 (1880), p. 371.

Superior molars three, rooted. Enamel forming three entrant loops on the external face of the crown, and one on the internal face.

While the number of the superior molars of *Paciculus* is as in the *Muridæ*, the details of their structure is much as in *Dasyprocta* and *Fiber*. Two species are known.

In the *P. lockingtonianus* the cranial characters are as follows: The infraorbital foramen is very large, with a general triangular outline. The superciliary borders and temporal ridges are well separated, and there is no sagittal crest. There are no postorbital processes. The otic bullæ are large, and furnished with a very large meatus auditorius externus. The malar is a narrow bone extending to the glenoid cavity posteriorly, and resting anteriorly on a prominent peduncle composed of the maxillary bone. It probably reaches the lachrymal.

This genus is probably one of the *Muridæ*, and a near ally of *Sigmodon* and *Neotoma*. It differs from these genera in having three external inflections of the enamel in the superior molars instead of two. It differs from *Hesperomys* as these two genera do, viz, in having deep enamel inflections instead of tubercles and valleys. It is true that the deepening and narrowing of the valleys of the molars of *Hesperomys* would result after wear in a pattern like that of *Neotoma*. The same process in *Eumys* would produce a pattern much the same as that of *Paciculus*, but that genus is further characterized by the contraction of the postorbital region and the production of a sagittal crest.

Two species of this genus are known to me, *P. insolitus*, a smaller, and *P. lockingtonianus*, a larger one. Both are from the Truckee beds of Oregon. They demonstrate an early origin for the American type of *Neotoma*, as contemporaries of the first of the *Hesperomys*.

ENTOPTYCHUS Cope.

Paleontological Bulletin No. 30, p. 2, December 3, 1878; Proceedings American Philosophical Society, 1878 and 1879, p. 64.

Family *Saccomyidæ*.* The cranium is elongate, and presents inflated periotic bones, and slender zygoma. The foramen infraorbitale is small and anterior in position, entering the maxillary bone near its suture with the premaxillary.

Generic characters.—Molars $\frac{4}{4}$–$\frac{4}{4}$, rootless, and identical in structure. The crowns are prismatic, and in the young stage present a deep inflection of enamel from one side, the external in the superior teeth, the internal in the inferior. After a little attrition, the connection with the external enamel layer disappears, and there remains a median transverse fossette, entirely inclosed by enamel. The tooth then consists of two dentinal columns in one cylinder of enamel, separated by a transverse enamel-bordered tube. Incisors not sulcate.

The teeth of this genus differ from those of *Perognathus* in being without distinct roots, and in having the enamel loop cut off and inclosed. In *Dipodomys*, the molars are undivided simple prisms.

The skull is compact, and does not display the vacuities or large foramina seen in some genera of *Rodentia*. The incisive foramina are rather small and posterior in position. There is a foramen on the side of the alisphenoid, which is nearly in the position of the anterior alisphenoid canal of the *Thomomys bulbivorus*. The foramen rotundum is immediately below and within the anterior part of the glenoid cavity. The foramen ovale is not distinct from the foramen lacerum anterius, and is on the external side of the apex of the petrous bone. The other *foramina lacera* are closed, so that the carotid foramen pierces the inner side of the otic bullæ. The condyloid foramen is close to the occipital condyle. The meatus auditorius externus is at the extremity of a tubular elongation of the bulla, and is separated by a space from the zygomatic process of the squamosal bone. Between the bases of these is a fossa which is bounded above by a ridge as in the genus *Castor*. Below this ridge is a subsquamosal foramen, and above it a postsquamosal. There are no postparietals nor mastoid foramina.

There are deep pterygoid fossæ, whose inner bounding laminæ unite on the middle of the palatine border, and whose external laminæ are continuous with the posterior extremity of the maxillary bone. The otic bullæ are not separated very distinctly from the mastoid. The latter looks like a continuation of the former, as in *Thomomys*, and occupies considerable space between the exoccipital and the squamosal. The latter sends downwards a process just posterior to the auricular meatus, which forms the handle to a hammer-shaped laminar bone. This is, no doubt, a dismemberment of the squamosal, as a similar process is continuous with that bone in *Thomomys*, and one somewhat dif-

* *Geomyidæ* Alston.

ferent is seen in *Neotoma*, *Hesperomys*, &c. Supraoccipital distinct on superior face of skull. Paroccipital process small or none. Mastoid elongate, adherent to otic tube. No postfrontal process.

A well-marked character which distinguishes the skull of this genus from *Thomomys*, *Dipodomys*, &c., is the separation of the meatal tube of the otic bulla from the zygomatic process of the squamosal bone by an interspace. There is no postsquamosal foramen in the recent genera. In *Dipodomys* the otic bulla is more largely developed, but it has the anterior bottle-neck prolongation seen in *Entoptychus*.

In the mandible the coronoid process is developed, but is not large It is well anterior to the condyle, which it somewhat exceeds in height The incisive alveolus forms a convexity on the outer side below the coronoid process. The angle is prominent, and is at first incurved below, and then turned outwards at the apex. The degree of obliquity of the grinding surfaces of the molar teeth vary with the species.

Parts of several skeletons are in my collection, but I cannot attach them to any cranium. They present the general characters of the genus *Thomomys* so far as they go. I describe some bones which apparently belong to one individual. The sacral vertebræ carry neural spines. There was evidently a well-developed tail. The scapula has a narrow glenoid cavity ending in a tuberosity adjacent to the coracoid hook. The spine is robust, terminating in a stout acromion. The tuberosities of the humerus are situated below the head, and are so rounded off as to be little prominent. One side of the greater is continued into a very prominent deltoid crest, which terminates abruptly below. The ilium has a narrow trilateral neck, and a projecting anterior inferior spine. The pubis is directed posteriorly at the base. The femur is not elongate. Its trochanters are well-marked, including a third. This is wanting in *Thomomys bulbivorus*. The neck rises obliquely to the rather large head. The condyles are short and spreading, and the rotular groove is short and rather wide, and with well-marked ridges. The tibia is much curved backwards at the proximal part. The crest is acute and is directed outwards, but does not project much at the head.

Individuals of this genus were very abundant in Oregon during the middle Miocene epoch. They represent several species, but how many it is difficult to determine. The most noteworthy variations are found in the development of superciliary ridges; then there are modifications in the forms of the premolar teeth, differences in the length and width of the muzzle, and some range in dimensions.

The following table represents the characters of the species so far as I can determine them at present:

A. Thickened superciliary ridges wanting; front wide.

Superciliary borders obtuse, not continued into temporal ridges; front flat, or or little concave; premolars narrow.

Length of skull .046 ..... *E. planifrons.*

Length of skull .038 ..... *E. minor.*

Superciliary borders sharp, vertical, continued into two straight temporal angles, which form a V.
Premolars narrow; size of *E. planifrons* ..... *E. lambdoideus.*
AA. Thickened ridge on the superior side of each supercilium; front narrower.
Superciliary ridges soon discontinued; size of *E. planifrons* ..... *E. cavifrons.*
AAA. Superciliary ridges much thickened, soon uniting, and closing the frontal groove behind. Front narrowest.
Premolar widened at the base; size of *E. planifrons* ..... *E. crassiramis.*

Some differences in the form of the mastoid bone may be observed in species of this genus. Thus it is flat behind, and bears a well-marked "lateral occipital" angle in *E. planifrons* and *E. lambdoideus*, while in the remaining species it is convex, and with the angle little apparent. In some specimens the loss of the hammer-shaped squamosal dismemberment, which I will call the posttympanic bone, gives a deceptive extension forwards to the mastoid.

Parts of more than a hundred individuals of *Entoptychus* are in my collection.

PLEUROLICUS Cope.

Paleontological Bulletin, No. 30, p. 3, December, 1878; Proceedings Amer. Philosoph. Society, 1878 (1879), p. 66.

Family *Saccomyidæ*. Superior molars rooted and short-crowned. The crowns with a lateral fissure bordered with an inflection of the enamel sheath, extending to their bases. In the superior molars this inflection is on the external side, and does not divide the crown. Superior incisors not grooved.

This genus is curiously near to the existing *Heteromys* and *Perognathus*, the two genera of *Saccomyidæ* with rooted molars. The former differs in having the molars divided into two columns, each of which is sheathed in enamel, while *Perognathus* only differs, so far as I am aware, in having the superior incisors grooved. It is also very nearly related to *Entoptychus*, and two of the species correspond in various respects with two of those of that genus. In view of the fact that most of the specimens of the *P. sulcifrons* are old individuals with well worn molars, the idea occurred to me that the rooted character of the molars might be common to the species of *Entoptychus*, but that it might not appear until long use had worn away most of the crown, and the protrusion had ceased. Examination of the bases of the long molars of *E. planifrons* did not reveal any roots. It is also opposed to this view that the maxillary bone in the *Pleurolici* has little depth below the orbital fossa, appropriately to the short-rooted molars, while the depth is considerable in the typical *Entoptychi*, though there is a complete gradation in this respect. But I have demonstrated satisfactorily that *Pleurolicus* is a distinct genus by observations on the *P. leptophrys*. Some of my individuals of this species are young, with the crowns of the molars little worn, yet the roots diverge immediately on entering the alveolus, on all the molars. In the species of *Pleurolicus* the lateral fissure of the

crown descends to its base, and hence persists longer than in the typical *Entoptychi*.

I am acquainted with two species of this genus. The posterior part of the skull of an individual represents a third species, which I refer provisionally to this genus.

The characters of the species are as follows:

I. Otic and mastoid bullæ continuous.
Temporal ridges uniting into a sagittal crest; length of skull .043; supraorbital ridges and concave front ..... *P. sulcifrons.*
Temporal ridges not uniting; length of skull .035; interorbital region flat: no ridges ..... *P. leptophrys.*
II. Otic and mastoid bullæ separated by a deep groove.
Temporal ridges not united; front concave; size medium; supraoccipital wide ..... *P. diplophysus.*

LAGOMORPHA.

PALAEOLAGUS Leidy.

Proceedings Academy Philada. 1856, p. 89; Extinct Mamm. Dakota and Nebraska, p. 331.— Cope, Ann. Report U. S. Geol. Survey Terrs. 1873 (1874), p. 477.

Family *Leporidæ*. Dentition: I. $\frac{2}{1}$; C. $\frac{0}{0}$; M. $\frac{6}{5}$; or, Pm. $\frac{3}{2}$, M. $\frac{3}{3}$. Superior incisors sulcate, inferior incisors not sulcate. First and last superior molars simple, intermediate ones with an enamel inflection of the inner side, which soon wears out. First inferior molar of one more or less transversely divided column; other inferior molars consisting of two columns in antero-posterior relation. No postfrontal process.

The above characters approximate nearly those of the existing genus *Lepus*. The only distinction between them signalized by Dr. Leidy, is the more simple first inferior molar of the extinct genus, which consists of one column more or less divided. In *Lepus* this tooth consists of two columns, the anterior of which is grooved again on the external side in the known species. I am able to reinforce this distinction by a strong character, viz, the absence of the postfrontal process in *Palæolagus*. As compared with the extinct genus *Titanomys* of Meyer,* the difference is well marked, as that genus has the molar teeth $\frac{3}{4}$ instead of $\frac{3}{3}$. The last inferior molar is cylindric, consisting of but one column. The first inferior molar consists of two cylinders broadly united, as in the corresponding tooth of *Palæolagus*. As compared with *Panolax* Cope,† which is only known from superior molar teeth, this genus may be at once recognized by the simplicity of the last tooth. In *Panolax* it consists of two columns.

Dr. Leidy's descriptions and figures, which are available for the definition of this genus, relate exclusively to the dentition. Characters

* *Amphilagus*. Catal. Méth. et Descr. Vertèbres Fossiles de la Bassin de la Loire, 1853, p. 42.

† Report Lieut. G. M. Wheeler, 4 to, IV, p. 296.

drawn from the skeleton generally can be derived from my material and are now given.

The nasal bones are wide, and the suture which separates them both from the frontal is concave forwards. The median frontal suture is persistent. The ascending portion of the premaxillary, which attains the frontal, is very narrow. The superior half of the facial plate of the maxillary bone is sharply rugose with reticulate ridges, but whether perforate or not I cannot certainly determine. The *foramen infraorbitale* is small and round, and issues below the reticulate portion of the maxillary. The otic bulla is compressed globular, with very thin walls. The meatus is large and has prominent lips, which open upwards. The mastoid is coössified with the bulla, and extends with a dense surface from behind to above and in front of the meatus. The incisive foramina are very large, enter the maxillary bones deeply, and are confluent posteriorly. The palate may be said to extend to the last molar, but there is a deep though narrow median posterior emargination.

The distal extremity of the *humerus* is not so extended transversely as in *Ischyromys*, and exhibits a moderate epicondyle. The inner flange of the condyles is well developed, and on the posterior face it is supplemented by a flange of the external edge of the condyles, which is as prominent or even more so, forming an intertrochlear crest. The arterial canal is inclosed by a slender bridge, and opens on the inner side above, and anteriorly below. In an ulna supposed to belong to this genus the coronoid process is elevated. The radial facet forms a narrow transverse plane, nearly divided by a wide anterior emargination. The shaft is compressed vertico-obliquely. A radius exhibits a transversely oval humeral face of the head somewhat angulate at a superior and an infero-lateral extremity, which are diagonally opposed to each other. Beyond the middle the shaft becomes wider, and is flattened obliquely.

The peduncle of the *ilium* has a triangular section, the anterior face being the narrowest, and inclined at a little more than a right angle to the interior face. It expands but little at the sacral extremity, and the crest is very short. The external angle of the peduncle is very prominent and runs into the anterior extremity of the crest, from which proceeds also the more obtuse angle which is continuous with the pectineal line. A third longitudinal angle is seen on the middle of the external side of the sacral extremity, which is not continued on the peduncle. There is a prominent tuberosity on the median or first-described angle, on the peduncle which may or may not be homologous with the anterior inferior spine. There is no tuberosity on the inner bounding angle of the inner face as is seen in *Gymnoptychus*. The pubis leaves the ilium at right angles. Acetabulum nearly round.

The *femur* has well developed great and little trochanters, and a third trochanter, which rises from the shaft in line with the inferior border of the little trochanter. The fossa of the great trochanter is well marked. The head is not separated from the great trochanter by a deep emargi-

nation, and projects well within the internal face of the shaft. Its articular surface is prolonged towards the great trochanter. *Fossa ligamenti teres* isolated. The distal extremity of the femur exhibits the superiorly prolonged patellar groove characteristic of this group of rodents. The condyles are more than elsewhere produced downwards and posteriorly, and are well separated.

The spine of the *tibia* is rudimental, and the crest is very obtuse. The inferior continuation of the latter forms a prominent reverted keel on the proximal front of the shaft, which is deeply concave on its inner side. The posterior face is also concave and is separated by a laminar external bone from the external side. The external border of the head is not deeply notched as in *Panolax*. The fibula unites with the tibia on the proximal part of the latter. The remainder of the shaft is smooth. The external malleolus is large and at right angles to the long diameter of the distal end of the bone, and its extremity is a facet for contact with the calcaneum. On its external face is a prominent process directed backwards. The external trochlear groove is deeper than the internal, and is well separated from it. The internal malleolus can scarcely be said to exist. It may be represented by a small process on the inner side of the extremity of the shaft.

The *astragalus* is elongate and flat, and the trochlear portion is oblique. The neck is elongate, and convex on the inner side; the constriction is on the inner side immediately behind the head. The long diameter of the latter makes an angle of 45° with the horizontal plane. The external trochlear arc is much larger than the internal. The cotylus, which fits the external condyle of the calcaneum, posesses a peculiar impressed area on its posterior surface. The calcaneum extends nearly as far anterior to its condyle as posterior. The free portion is subcylindric or subquadrate to the end. The internal process for the astragalus is quite prominent. The cuboid facet is directed obliquely inwards, running into a short longitudinal groove. The cuboid extremity is little depressed.

The skeletal characters above enumerated were taken from the bones of *P. largidus* and *P. haydeni*, excepting in the cases of the ulna, radius, ilium, and calcaneum, which were derived from those of *P. haydeni* only.

A cast of the cranial chamber of a specimen of *Palæolagus haydeni* displays the superficial characters of the *brain*. As in the order generally, the hemispheres are small and are contracted anteriorly. The greater part of the cast of the cerebellum is lost, but enough remains to show that it was large. The olfactory lobes are large; they are not gradually contracted to the hemispheres, but expand abruptly in front of them, being separated by a constriction only. They are wider than long, and than the anterior extremity of the hemispheres. Their cribriform surface is wide, and extends backwards on the outer sides. Traces of the three longitudinal convolutions can be observed on the hemispheres above the *lobus hippocampi*. The internal and median are con-

tinuous at both extremities, and extend with the external to the base of the olfactory lobes. There is no definite indication of the Sylvian fissure. The *lobus hippocampi* protrudes laterally a little beyond the border of the external convolution. Its form is depressed.

As compared with the brain of the rabbit (*Lepus cuniculus*) figured by Leuret and Gratiolet*, that of the *Palæolagus haydeni* is distinguished by the absolutely much smaller size of the hemispheres, and by the absolutely larger olfactory lobes, the excess being in transverse dimensions and not in the longitudinal. An important difference is also the absence of the median posterior production of the hemispheres seen in the rabbit, the prolongation in the extinct species being lateral, and extending little behind the *lobus hippocampi*. The indications of the convolutions of the superior surface are similar in the two.

As observed by Leidy, this genus presents the same number of teeth as in the existing rabbits, viz, I. $\frac{2}{1}$; C. $\frac{0}{0}$; M. $\frac{6}{6}$; and that the difference consists in the fact that the first molar possesses two columns, while in *Lepus* there are three. Having collected a great number of remains of this genus, I am able to show that it is only in the immature state of the first molar that it exhibits a double column, and that in the fully adult animal it consists of a single column with a groove on its external face. The dentition undergoes other still more important changes with progressing age, so as to present the appearance of difference of species at different periods. These will be explained under the head of the *P. haydeni*, the most abundantly represented in the collections. It may be mentioned here that in neither *P. haydeni* nor *P. turgidus* is there any evidence that more than two anterior molars are preceded by deciduous teeth. The latter are present in many specimens.

Four species of this genus are known to have lived in Colorado during the White River epoch of the Miocene. Bones of two of the species have been found also in Dakota. The *P. haydeni* was probably the most abundant mammal of the fauna of that period.

Depth of ramus at penultimate molar, 6^{mm}; length of inferior molar series, 10^{mm}; no third lobe to molars ..... *P. agapetillus.*

Depth of ramus at penultimate molar, 9^{mm}; length of molar series, 10^{mm}; no third lobe to molars ..... *P. haydeni.*

Depth of ramus at penultimate molar, 11^{mm}; length of tooth series, 14^{mm}; a third posterior lobe of the molars ..... *P. triplex.*

Depth of ramus at penultimate molar, 12–14^{mm}; length of tooth series, 13-16^{mm}; no. third lobe ..... *P. turgidus.*

LEPUS Linn.

Dental formula: I. $\frac{2}{1}$; C. $\frac{0}{0}$; P-m. $\frac{3}{2}$; M. $\frac{3}{3}$. First superior molar simple; first inferior molar with two external grooves; last inferior molars consisting of two cylinders. Postorbital processes present.

I am acquainted with but one extinct species of this genus, and this is from the Truckee or Middle Miocene period. It proves the ancient

*Anatomie Comparée du Système Nerveux, Pl. III, Figs. 1, 2.

origin of this genus now so widely distributed over the earth. Species of *Lepus* are reported by the Gervais from the Miocene (Montabuzard) and Pliocene (Montpelier) of France.

LEPUS ENNISIANUS Cope.

This species is abundant in the Miocene beds of the John Day River Oregon, associated with a species which I cannot distinguish from the *Palaeolagus haydeni*. The *Lepus ennisianus* exceeds the last-named species in dimensions, being intermediate between it and the *Palaeolagus turgidus*.

The form of the skull and character of the postorbital processes refer this species to the neighborhood of the *Lepus auduboni* and *L. bachmani*.* The former has the general outline of that of *Lepus sylvaticus*, with which it nearly agrees in size. The postorbital processes are free and shorter and narrower than those of the *L. auduboni*. The supraorbital notch is insignificant, and is not bounded by either an angle of the border or a process. Behind the postorbital processes the cranium is narrower. The parietal region is convex in both directions. The interorbital and base of the nasal region are flat. The middle of the superior part of the occipital projects table-like beyond the lateral portions, as in recent rabbits. The otic bulla is large and is flattend on the external side. The mastoid presents some subvertical grooves. The paroccipital process is rather short and is turned backwards at the apex.

The mandible has much the form of that of *L. sylvaticus*, with certain differences. A slight convexity of the anterior border of the ascending ramus is the only trace of coronoid process. The posterior border of the same projects very little behind the condyle, and is but slightly concave below that point. The inferior border of the masseteric fossa terminates below the anterior border of the base of the coronoid process, which is posterior to the corresponding position in *L. sylvaticus*. Here the masseteric fossa extends as far forwards as the line of the posterior part of the fourth inferior molar.

The superior molars have the form usual in this genus. The crowns are grooved on both the external and internal faces. The first has less transverse extent than the others (except the sixth), and has a shallow groove on the anterior face. The sixth molar is a small and simple cylinder. Of the inferior molars, the first has the greatest anteroposterior diameter, while the transverse is equal to that of the others. Of its external grooves the posterior is the strongest. The last molar is much the smallest, and its section is a figure 8, with the widest circle next to the fourth molar. The anterior column of the other molars wears so as to be higher than the posterior. Its inner edge carries a shallow groove, while the external edge is narrow and smooth, and their alveoli terminate in a swelling below the first molar (Pm. III). The groove of the superior incisors is nearer the internal than the external side. The inferior incisors are perfectly flat.

*See Baird, Mammalia of the U. S., Pac. R. R. Surveys, VIII, p. 574.

Measurements.

	M.
Length of skull from inion to above Pm. II	.048
Length from inion to base of postorbital process (axial)	.032
Width of skull at glenoid cavities	.020
Width of skull behind bases of postorbital processes	.009
Vertical diameter of orbit	.0125
Depth of skull and mandible in place, at middle of orbit	.0310
Depth of mandible at condyle	.0310
Length of mandible to exit of incisor	.044
Depth of mandible at last molar	.011
Depth of mandible at middle of diastema	.005
Length of superior molar series	.012
Width of Pm. II (above)	.002
Width of M. I	.003
Length of inferior molar series	.013
Length of inferior Pm. III	.003

A fragmentary skeleton is associated with jaws and teeth of this species, and they are presumably parts of the same animal. They resemble the corresponding parts of *Lepus sylvaticus*, but are relatively smaller. The centrum of a lumbar vertebra is much depressed. There is a prominent anterior inferior spine of the ilium. On the internal side of the distal end of the tibia the ligamentous groove is more, and its bounding process is less, distinct than in *L. sylvaticus*.

Measurements.

		M.
Width of centrum of lumbar vertebra		.0083
Depth of centrum of lumbar vertebra		.0040
Diameter of acetabulum		.0060
Diameters of head of tibia	anteroposterior	.011
	transverse	.0105
Diameter of distal end of tibia	anteroposterior	.0046
	transverse	.009
Length of free part of calcaneum		.007

From the John Day River and the north fork of the John Day River, Oregon. C. H. Sternberg.

This rabbit is the oldest species which can be referred to the genus *Lepus*. It is dedicated to my friend Prof. Jacob Ennis, of Philadelphia, the distinguished mathematician and physicist.